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ABSTRACT

This report reviews current literature on feedback and suggests practical implications of feedback research for educators. A definition of feedback is offered, and past definitions in prior research are noted. An analysis of the current state of knowledge of feedback discusses the historical development of feedback theory and suggests that disagreements have not been on the external manifestations of the theories expounded by Descartes, Thorndike, Watson, or Skinner, but in their teleology. Also discussed is the importance of the immediacy of feedback, delayed information feedback, and other variables affecting feedback. Conclusions suggest that feedback is a complex process which can no longer be adequately described within the parameters of the traditionally held Stimulus-Response (S-R) paradigm, nor can it be said that "immediate" feedback must be given, or that delayed feedback is more effective in learning. It is proposed that feedback must be viewed as knowledge of response affected by variables within the individual and in the environment, and that research should be conducted by comparing different methods of feedback with the same students and the same subject matter. Fifty-two references are listed. (LMM)

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Feedback: Implications for Further Research and Study

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INTRODUCTION

A commonly accepted theory believed to be essential in the learning process is that knowledge of the correctness of response be provided the learner as quickly as possible to enable him to acquire and retain information. This theory of immediate feedback has pervaded instruction since early studies in behavioral science where it found greatest support.

A review of current literature in feedback seems to indicate that more evidence is being generated which essentially questions the validity of the concept of "immediate feedback" as a general procedure and that while its effectiveness in certain types of learning is evident, it is not always an essential part of the learning process. In view of the controversy that appears to exist, this paper will attempt to provide a better understanding of feedback (FB) by assimilating various research data into a philosophy that should have relevance to practitioners involved in the teaching/training/learning process.

FEEDBACK: What is it?

While feedback may literally be defined as "the return to a point of origin of evaluative or corrective information about an action or process" its etiology appears to be so complex that an accurate description of the process and the effect it has on acquisition and retention of information remains obscure. Although there is total agreement that FB plays an important part in the learning process, there is

still much conjecture regarding what the process involves, the direction it takes, what variables affect it, the learner's role, and the terminal result.

Moreover, FB is thought to be synomymous with reinforcement and, as such, has been categorized as tangible, symbolic and verbal. Van Houten (1980), for example, states that providing visual FB enhances the acquisition of the most complex motor tasks and for FB to be effective, it must be administered precisely and recorded in numerical terms. As described, however, visual FB is a form of reward intended to reinforce an acceptable behavior.

Basically, all FB originates from some source. Although it is believed that the source is technically not a part of FB, the two are often confounded because in order to understand the effects of FB on behavior, the source must be identified and then, its influence upon the response recognized (Ilgen, Fisher & Taylor, 1979). When applied to human learning, FB can prove to be a simple Stimulus-Response (S-R), Yes-No, or a complex remedial situation. If viewed as a unitary variable, its properties may vary in simplicity and complexity along the continuum in which the process itself could take the form of new instruction as FB complexity increases (Kulhavy, 1977). As such, FB may be directional as well as motivational; while it informs learners of what behaviors should be accomplished it can also provide information about the outcome associated with reward, act as an incentive and serve as reward or punishment (Ilgen, et al. 1979).

In addition, various types and combinations of FB which serve different functions in conceptual and behavioral tasks have also been identified (Brackbill & O'Hara, 1958; & Spence, 1966, 1971),

1. Right-Wrong: FB which follows both correct and incorrect responses,

2. Right-Blank: FB which follows correct responses but does not follow incorrect responses, and

3. Wrong-Blank: FB which follows incorrect responses but does not follow correct responses (Barringer & Gohlson, 1979).

Wrong-Blank and Right-Wrong combinations in verbal FB is said to produce equivalent performance superior to that produced by Right-Blank, however, Wrong, it appears, is a more powerful negative reinforcer than Right is a positive reinforcer (Buss & Buss, 1956). Blank is interpreted as positive FB at the outset of acquisition in the Wrong-Blank situation acquires a positive FB meaning in a few trials. Blank in Right-Blank, however, acquires its appropriate meaning slowly and inconsistently (Spence, 1966). It is conjectured that the superiority of the Wrong-Blank combination over the Right-Blank during acquisition of information may be attributed to the interpretation of Blank as signalling a correct response and/or that Blank acquires its meaning earlier when the Wrong-Blank condition is encountered (Buchwald, 1959). When no FB follows either a right or wrong response, however, a given hypothesis is maintained and the tendency to repeat a response on

consecutive trials, assuming the Blank to mean "correct", exists (Levine, 1966).

AN ANALYSIS

Despite the many attempts at clarifying FB functions, the total concept of FB remains as controversial now as it was at the time of its inception. The Spencerian view that "the development of a behavioral repertoire in the individual is a mechanical unintelligent analog of the evolution of behavior repertoires in different species" was predominant at the time the field of behavioral sciences was beginning to take a foothold as a science in the 1800's. All behavior was readily interpreted by applying Spencer's theory that complex stimuli, for example, were the result of chaining together of simple reflexes, a theory obviously based on Descartes' reflex arc and Hobbes' argument that all human action could be understood in terms of mechanical principles (Schwartz, 1978).

The impetus to moving inquiry about human nature into the laboratory and to incorporating the doctrines of Associationism into scientific psychology was initiated by Ebbinghaus (1850-1909) who, using himself as a subject, developed a set of empirical laws of association. Implicit was the view that an understanding of complex ideas reflects a past history of association of simple ones. While this was an important step and a first toward behavior theory, it was Pavlov (1849-1936) whose study of conditional reflexes and association of ideas in the laboratory at the turn of

the century produced results that could be seen and measured that transformed the study of the laws of the mind into the study of human behavior (Schwartz, 1978).

Influenced by Pavlov's studies, Watson, in America, arrived at behavioristic views, essentially that all there is to human nature is behavior, from an interest in animal research. It was Watson's belief that the same objectives of scientific observation could be applied to the study of human behavior - that the data collected by the psychologist should be no different from those recorded by the physical scientist (Spence, 1956).

While the simple reflex arc theory could adequately describe simple behaviors, it did not suffice to explain complex behavior. It was Thorndike's study of the behvior of a caged cat that resulted in the "law of effect", a theory upon which operant conditoning was later to be based (Saettler, 1968). Behavior, in Thorndike's view was a collection of simple reflexes but one that proposed action with a purpose - not the result of some triggered stimulus, rather the result of some anticipated goal. What primarily influences behavior is feedback - its consequences - which is automatic. Acts that produce favorable consequences are continued and those with unfavorable consequences are terminated (Schwartz, 1978; Spence, 1956).

The impact of this conception of feedback on American education cannot be overly exaggerated. Skinner, establishing his methods on earlier studies by Thorndike and on the results gathered from human and animal studies, was

convinced that all human behavior is shaped by the reinforcement of correct behavior, clearly an endorsement of the S-R theory.

FURTHER ANALYZED

While there are still those whose propensities are that FB may be encumbered within the S-R theory, research continues to produce evidence that FB is considerably more complex than heretofor thought to be. Annett (1969), for example, analyzes FB as action FB and learning FB. While action FB occurs during a response and may affect the response while it is happening, learning FB occurs after a response delayed long enough not to be affected by the response.

In effect, action FB as it is described may be viewed as a linear S-R condition while learning FB may be identified as a closed loop best compared with Weiner's servo-mechanism model where FB can be graphically represented as a function controlled by the consequences of its own behavior (Annett, 1969). Like a servo-mechanism it has a source; a transducer, a device which measures the input and output of the machine and a FB loop which translates the output measure into a signal which can control the input. Such a FB controlled system has the property of maintaining a set level of outputs regardless of fluctuations in the "load" imposed by the environment. Evidence of these characteristics may be recognized in a simple discrimination act of picking up a lead weight and a

ball - not as much effort is expended into lifting the light weight as the heavier lead weight. The tendency of the system to maintain equilibrium in the internal environment demonstrates the existence of the servo-control system. An interruption of the system causes a disruption in the equilibrium of the system.

While Annett's (1969) analysis may represent a breakthrough in a better understanding of FB, accumulating evidence indicates that stimuli depend on responses according to the current organization of the entire body in which the nervous system resides, that all behavior involves FB effects (Powers, 1973). Literally, all FB is behavior. When a certain behavior is exhibited, it is the result of FB effects of the individual's output. Presumably behavior is controlled perception, not simply a reaction to some stimulus. Where goals and purposes for behavior could not have been accounted for previously, they can now be viewed as a part of the FB process and, moreover, explain why different variables produce the same results. An animal, trained to walk a certain pattern seems to follow a consistent pattern with each trial, yet upon close examination the movements are not exactly the same. When the cage is tipped, the animal continues to walk the learned pattern, compensating for the tipped cage. The animal changes its behavior though the pattern remains unchanged.

Powers (1973), in explaining this phenomenon, states that all behavior is goal-oriented at all times around the control of certain quantities in respect to specific

referent conditions. When a learner acts, it is in counteraction to the effects of a disturbance on certain controlled quantities. Only this difference between the quantities and its reference condition produces the response/behavior. It is not the situation that causes the response; it is how the subject or learner perceives the situation.

Controlled perception however does not mean the absence of control by the learner; on the contrary there is control when a new reference condition arises but each action occurs according to a hierarchy of controlled quantities where one controlled quantity is controlled by means of changing the reference level with respect to which a second quantity is controlled - the top of the hierarchy answering the question "Why?" and going down to the second level "How?". Fast enough variations in the controlled quantitites, however, cannot all be sorted out, therefore they become noise with respect to behavior.

IMMEDIATE FEEDBACK

As significant as these various functions of FB have been found to be in the acquisition and retention of information, the immediacy with which FB is presented has long been believed to be essential (Skinner, 1954). Based largely on direct application of Thorndike's Law of Effect and Skinner's operant conditoning assumptions, the practice of presenting immediate FB to reinforce the correct or desired response/behavior immediately and frequently to

ensure the establishment of that response/behavior was hypothesized as the result of repeated experiments both in the laboratory and out. To behaviorists, the supportive data amassed was evidence that despite the obvious differences between small animals and humans, all organisms show similar learning process properties. It was generally believed that only by manipulating reinforcement could the behavior of the individual organism be brought under control (Skinner, 1954).

Although pioneering efforts in the application of the reinforcement theory began with Pressey's (Pressey, 1950) punchboard, a device used in giving the learner immediate knowledge of response in self-instruction and self-correction, it was the meteoric popularity of Skinner's teaching machine and programmed instruction efforts in the 60's that seemed to verify the prediction by behaviorists' that these techniques would revolutionize education (Skinner, 1960).

Despite the flurry of activity in programmed instruction and the massive amount of data accumulated by behaviorists as to their successes, the use of teaching machines and programmed instruction gradually diminished. Although its demise may be due to teacher resistance in more than a few cases, its disfavor might also be due to the inapplicability of the Skinnerian theory to all learning situations as had been claimed or assumed.

Evidence of the effectiveness of another type of FB, Delayed Feedback (DFB) was concurrently being produced in

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direct contradiction of the theory of immediate FB.

DELAYED INFORMATION FEEDBACK (DIF)

Probably the most important and subsequently the most discussed and examined aspect of verbal feedback has been in the effects of a phenomenon most often referred to as delayed-information feedback (DIF), that is, delaying the presentation of feedback for a period of time. Studies in DIF describe the effect of delay of information on retention to be dependent on the type of information FB, the length of delay and the type of material to be learned. Delay has been shown to improve retention of meaningful, not nonsense, material when the information feedback consists of the entire item with the correct answer (Sturges & Crawford, 1964). Generally, no significant difference has been shown to exist in retention between immediate information FB and DIF when the information FB of meaningful material is only a cue suggesting the correct answer (Brackbill, Bravos & Starr, 1962; Sturges, Sarafino & Donaldson, 1968; Sassenrath and Yonge, 1968).

Although the effects of DIF have been widely researched, assumptions of its etiology reveal as much speculation and disparity among researchers now as ever before. While it can be conjectured that DIF improves later performance as the result of covert, symbolic activity which occurs between the initial presentation and FB (Sturges & Crawford, 1964); it is also theorized that subjects use language to relate delayed FB to earlier learning

(Sassenrath and Yonge, 1968). The use of response-produced, external or verbal cues to help mediate the delay period or language to related delayed FB to earlier learning are believed to be essential in the regulation of one's behavior with respect to remembering past events and anticipating future events (Brackbill & Kappy, 1962).

On the basis of studies with human subjects, Kulhavy and Anderson (1972) theorize that incorrect responses are forgotten over a period of time and that this forgetting tends to facilitate the learning of correct responses whereas in immediate FB, there is proactive interference from committed incorrect responses. The delay period allows a person to forget the wrong answer which acts as interference and facilitates the acquisition of the correct response. That this Interference-Perseveration occurs is contingent upon the learner and his ability to comprehend the material being tested (Kulhavy, 1977). If the material is too difficult and unfamiliar, and the student attempts answering items by guessing, then the value of FB becomea a moot point.

The theory holds particularly true when test items, for example, are of the multiple-choice type where the stems of the items are identical but the results are antagonistic. Delay-Retention-Effect (DRE) provides the learner with information about the accuracy of what has already been learned and provides an avenue by which wrong answers may be corrected (Kulhavy, 1977; Surber & Anderson, 1975). Positive feedback however, is not affected by the

interference when given immediately after the response or later, so the delay is less of an issue (Ilgen, et al., 1979).

In comparison with the substantial amount of data supporting immediate FB as an effective instructional technique, scant data on which to develop generalizable assumptions about delayed FB exist. Although there is growing evidence that DRE is more effective under certain circumstances than immediate FB, the wide acceptance of it has overshadowed attempts to reexamine delayed FB in light of new evidence. Additionally, there are studies which show the ineffectiveness or the "no-difference" effect of Delayed-Retention-Effect (DRE) as described in a review of 14 studies by Sassenrath and Yonge (1968) which show only two that favor DIF to be significantly effective in learning efficiency and eleven which show no significant difference. Verbal, concept or discrimination learning is shown not totally affected by DIF, but is affected by the interaction of other variables: size of population sampled (Beck and Lindsey, 1979), composition of population sampled (Krumboltz & Weisman, 1962), lack of control in test administration (Sullivan, Schutz and Baker, 1967), and the amount of cueing supplied (Sturges, 1969, 1972; Sassenrath, 1969, 1975; Spartz & Sassenrath, 1972).

OTHER VARIABLES THAT AFFECT FB

To add to the complexities obviously inherent in the FB process, it is proposed that FB may also be a function of

the initial learning state, that individual differences among learners must be considered before any judgement can be made about what may be causing specific behaviors and why (Newman, Williams and Hiller, 1974). Besides the strong relationship found to exist between self-concept and performance (Boersma, Chapman & Battle, 1979) there is indication that students with low aptitude scores received the most benefit from delayed knowledge of results and that students with higher scores show little difference in advantage of one treatment over the other. Joseph and Maguire (1982) propose that individual differences among students must be considered before any judgement can be made about what may be causing a certain behavior and why.

Even as studies attempt to clarify these issues, other interacting variables appear to be actively involved in the process. Reinforcement schedules, autonomy need and achievement studied in a programmed course showed that with college students, highest scores were recorded of above-average aptitude students with no reinforcement and the lowest with continuous reinforcement, however on the criterion test, high autonomy-need students scored lower. It could be concluded that students who have high autonomy needs, being high achievers also are frustrated by the expectations and requirements of the instruction and the low autonomy-need group felt more comfortable because they did not feel the need to achieve. Similarly, students with higher academic achievement have been found to have greater ability to give internal feedback (self-feedback) where less

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dependence on external feedback is exhibited (Lublin, 1965).

Locus of control, another variable related to academic achievement, has been found in some studies to interact with FB. Statistically significant correlation between locus of control and internal FB and external FB variables when academic achievement is used as a dependent variable has been found (Maqsud, 1983; Baron & Ganz, 1972). While the internal aspect of FB has its interacting influences, so does the external. There appears to be a link between FB stimulus and the perceived FB with the stability of that link dependent on the characteristics of the source, the stimulus and the learner - the more positive, the more powerful and credible the source, the more accurately is the FB perceived. Peer influence; teacher power, expertise, status and influence, and status in the environment all affect the FB process (Baron, Cowan, Ganz & McDonald, 1974; Root & Gall, 1981).

Additionally, the effect of socio-economic status, race of learner and experimenter and praise, criticism and silence as FB on performance was studied. While no differences were noted with the type of FB, significant interactions were found (Baron et al., 1974).

IMPLICATIONS

Without doubt, prima facie evidence dictates that application of FB not be attempted indiscriminately nor unpremeditatedly. Yet textbooks freely list "immediate feedback" as one of the essential principles in teaching.

The texts ignore altogether any other type or combination of FB or the consequences of timing of FB. As a result, teachers have for years striven to return graded test papers as quickly as possible, believing it to be an effective teaching technique.

Of yet greater concern is the current prolific application of the principles which underlie immediate feedback in the design and development of computer-assisted instruction (CAI). Despite the numerous studies that indicate individualized instruction to be a very complex methodology which requires the use of reliable and valid teaching material besides an understanding of individual learning processes, much of the computer software currently available are samples of programmed instruction as it existed ten years ago.

A review of the literature on feedback will also describe other studies of extreme relevancy to those involved in the instructional process. As often as it is suggested, tangible FB, or material reward, may not provide for rapid acquisition of information (Spence, 1971; Spence & Segner, 1967) and sometimes produces the poorest performance (Mims & Gohlson, 1977). There is ample evidence that tangible FB such as candy, toys and money can be effectively used to control human behavior (Anderson, 1967), however there has been a reluctance to employ this method because educators would prefer to use "intrinsic reinforcement". The objection to "extrinsic reinforcement" is the inherent fear that the student will become too dependent on receiving

such FB and be unable to perform without it. In addition, tangible FB may distract from the relevant stimuli and produce a deficit in performance (Mims & Gohlson, 1977, Spence & Segner, 1967).

Tangible rewards seem to be especially important to disadvantaged, retarded, disturbed, or very young children (Lysakowski & Walberg, 1981). Although tangible rewards are objectionable to many educators, they have been used effectively on a variety of students ranging from high school dropouts to grade school children with academic achievement problems and, in addition, have been successfully employed in a number of settings, from the psychiatric ward to the classroom (Anderson, 1967) to industry (Ilgen, et al., 1979) In certain situations, the extrinsic reward is required in a learning task to maintain control of instructional materials over student responses. It is said that regardless of the quality of the material, unless the student is given an incentive, he will not learn the lesson well. Yet, as described earlier, the effect of extrinsic rewards are highly contingent upon the individual and environmental variables.

Regardless of intent, the accommodation for individual differences in all children would prove to be a difficult, if not impossible task to undertake. Yet, the fact remains that for FB to be most effective, individual differences must be attended to. Forness (1973) proposes an heirarchy of FB and/or reinforcement for different individual types as an initial step in the determination of appropriate

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administration of FB:

1. The competent ones who "learn for the reward of mastery.

2. Those who require positive FB about the correctness of a response.

3. Those who need social approval.

4. Those who react contingent upon the nature of the activity.

5. Those who need token FB (could be symbolic reinforcement).

6. Those who require tangibles such as toys, money, etc.

7. Those who need edible rewards.

Perhaps the most significant application of immediate FB could be found in the development of programmed instruction where immediate responses were required to small frames of instruction. Although the effectiveness and efficiency of the immediate response is still believed to be true, several studies show that performance may be better with no knowledge of response (Lublin, 1965). It is hypothesized that when no knowledge of the correct response is given, each frame demanded more attention from the students and required them to study each frame more carefully. The results of Lublin's study lend support to the idea that programmed instruction should be written in large steps rather than small ones (Krumboltz, 1964). According to Keller (1968) instruction should be in

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principal steps and not simply "frames" in a "set".

CONCLUSION

Clearly, FB is a complex process which can no longer be adequately described within the parameters of the traditionally held S-R paradigm, nor can it be said that "immediate" FB must be given, or that delayed FB is more effective in learning. Rather, FB in all its complexity must be viewed as knowledge of response affected by variables within the individual and in the environment. Although the Skinnerian theory or operant conditioning serves to enhance some types of learning, it has been found to be ineffective in others. A strict adherence to one concept, as is most unfortunately recommended in many textbooks on instructional procedures, ignores the existence of scientific evidence at the expense of the learner. The developmental study of FB indicates disagreement not on the external manifestations of the theories that have been expounded by Descrates, Thorndike, Watson or Skinner but in their teleology. Each theory appears to have used the latter as a foundation upon which to build a better and more comprehensive theory. There is great similarity between Thorndike's "law of effect" and Power's theory of goal-oriented behavior, for example. The influence of behaviorism and the practice of immediate FB have so pervaded instruction over the past 60 years that much of what have been developed toward the improvement of instruction indicate a total reliance on the guidance of

immediate feedback. While much data can be provided in proving its success, scant data can be found in support of other methods.

Feedback will remain an enigma until research is conducted comparing the different methods of FB on the same students and the same subject matter. Until then, educators must rely on the sparse current studies on FB to use it effectively and efficiently in instruction.

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